7. CLAIMS

What is claimed is:

1. A compensator for a liquid crystal display, wherein:

(a) said compensator comprises a layer of a birefringent material having an optical symmetry axis;

(b) said birefringent material comprises a polymer matrix including polymerized nematic material and unpolymerized nematic material; and

(c) each of (i) a tilt angle ϕ, relative to the plane of the layer, and (ii) an azimuthal angle θ, relative to a reference axis in the plane of the layer, of said optical symmetry axis varies along an axis normal to said layer; and

(d) said variations in tilt angle and azimuthal angle being defined by a combination of molecular orientations of said polymerized nematic material and said unpolymerized nematic material.

Sub a1

2. A compensator for a liquid crystal display, said compensator comprising a layer of a birefringent material having an optical symmetry axis, wherein said optical symmetry axis varies along an axis normal to said layer.

3. The compensator of claim 2, wherein said layer of birefringent material comprises a polymer matrix that defines said variation of the optical symmetry axis, said polymer matrix comprising polymerized nematic material.

4. The compensator of claim 2, wherein said layer of birefringent material comprises a polymer matrix, said polymer matrix including polymerized nematic material and unpolymerized nematic material having respective molecular orientations which, in combination, define said variation of the optical symmetry axis.

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5. The compensator of claim 2, wherein an azimuthal angle θ, relative to a reference axis in the plane of the layer, of said optical symmetry axis varies along an axis normal to said layer.

6. The compensator of claim 2, wherein a tilt angle ϕ, relative to the plane of the layer, of the optical symmetry axis varies along an axis normal to said layer.

7. The compensator of claim 2, wherein each of (i) a tilt angle ϕ, relative to the plane of the layer, and (ii) an azimuthal angle θ, relative to a reference axis in the plane of the layer, of said optical symmetry axis varies along an axis normal to said layer.

8. A compensator for a liquid crystal display, said compensator comprising a plurality of layers, each layer comprising a birefringent material having an optical symmetry axis which varies along an axis normal to said layer.

9. The compensator of claim 8, wherein:

(1) the optical symmetry axis of each layer has an azimuthal angle θ which varies along an axis normal to said layer; and

(2) the optical symmetry axes of adjacent said layers vary azimuthally in a positive sense and a negative sense respectively.

10. The compensator of claim 9, wherein the optical symmetry axis of each layer has a tilt angle ϕ which varies along an axis normal to said layer.

11. The compensator of claim 10, wherein the tilt angles of adjacent said layers vary in a positive sense and a negative sense respectively.

12. The compensator of claim 8, wherein (1) the birefringent material in each said layer includes a plurality of moieties of a liquid-crystal material, and (2) a specified said layer aligns the moieties of liquid crystal material in an adjacent said layer.

a1

13. A compensator for a liquid crystal display, said compensator comprising a plurality of layers, wherein:

(a) each layer comprises a birefringent material including a plurality of moieties of a liquid crystal material;

(b) the optical symmetry axis of each layer has a respective tilt angle ϕ, relative to the plane of the layer, which varies along an axis normal to the layer, with the tilt angles of adjacent said layers varying in a positive sense and a negative sense respectively;

(c) the optical symmetry axis of each layer has a respective azimuthal angle θ, relative to a reference axis in the plane of the layer, which varies along an axis normal to said layer, with the azimuthal angles of adjacent said layers varying in a positive sense and a negative sense respectively; and

(d) a specified said layer aligns the moieties of liquid crystal material in an adjacent said layer.

Sub a2

14. The compensator of a specified one of claims 2 or 8, further comprising one or more A-plate layers.

Sub C5

15. The compensator of claim 14, further comprising one or more C-plate layers.

16. A method of manufacturing an O-plate compensator having a layer of a birefringent material, referred to as a compensator layer, said birefringent material

having an optical symmetry axis which varies along an axis normal to said layer, said method comprising the steps of:

(a) providing a substrate;

(b) applying a liquid crystal alignment layer to said substrate;

(c) applying to said alignment layer a thin film of a polymerizable liquid crystal material that has:

(1) a specified air-nematic tilt angle,

(2) a pre-tilt angle on said alignment layer, said pre-tilt angle differing from said air-nematic tilt angle by an amount sufficient to produce a desired splay of the orientation of the optical symmetry axis through the thin film, and

(3) a cholesteric pitch that produces a desired twist in the orientation of the optical symmetry axis through the thin film;

(d) heat-treating said thin film to obtain a specified director orientation configuration of said thin film; and

(e) illuminating said thin film with actinic radiation to polymerize said thin film.

17. A method of manufacturing an O-plate compensator having a layer of a birefringent material, referred to as a compensator layer, said birefringent material having an optical symmetry axis which varies along an axis normal to said layer, said method comprising the steps of:

(a) providing a substrate;

(b) applying a liquid crystal alignment layer to said substrate;

(c) applying to said alignment layer a thin film of a polymerizable nematic liquid crystal material that has one or more of:

(1) a specified air-nematic tilt angle and a pre-tilt angle on said alignment layer, said pre-tilt angle differing from said air-nematic tilt angle by an

amount sufficient to produce a desired splay of the orientation of the optical symmetry axis through the thin film, and

(2) a cholesteric pitch that produces a desired twist in the orientation of the optical symmetry axis through the thin film;

(d) heat-treating said thin film to obtain a specified configuration of the orientation of the optical symmetry axis through said thin film; and

(e) illuminating said thin film with actinic radiation to polymerize said thin film.

18. The method of claim 17, wherein said step (c) of applying a thin film comprises the substeps of:

(1) dissolving said liquid crystal material in a solvent to form a solution,

(2) applying said solution to said alignment layer, and

(3) evaporating said solvent to form said thin film.

19. The method of claim 17, wherein said alignment layer is a previous thin-film layer of the kind described in step (c).

20. A method of manufacturing an O-plate compensator having a layer of a birefringent material, referred to as a compensator layer, said birefringent material having an optical symmetry axis which varies along an axis normal to said layer, said method comprising the steps of:

(a) providing a substrate;

(b) applying a liquid crystal alignment layer to said substrate;

(c) applying to said alignment layer a thin film of a polymerizable liquid crystal material that has a chiral smectic-C phase having a pitch greater than

the thickness of the thin film to produce a desired twist in the orientation of the optical symmetry axis through the thin film;

(d) heat-treating said thin film to obtain a specified configuration of the orientation of the optical symmetry axis through said thin film; and

(e) illuminating said thin film with actinic radiation to polymerize said thin film.

21. The method of claim 20, wherein said step (c) of applying a thin film comprises the substeps of:

(1) dissolving said liquid crystal material in a solvent to form a solution,

(2) applying said solution to said alignment layer, and

(3) evaporating said solvent to form said thin film.

22. The method of claim 20, wherein said alignment layer is a previous thin-film layer of the kind described in step (c).

23. A liquid crystal display for viewing at various angles with respect to a normal axis perpendicular to the display, comprising:

(a) a polarizer layer;

(b) an analyzer layer;

(c) a liquid crystal layer disposed between the polarizer layer and the analyzer layer;

(d) a first electrode proximate to a first major surface of the liquid crystal layer;

(e) a second electrode proximate to a second major surface of the liquid crystal layer, the first and second electrodes being adapted to apply a voltage

across the liquid crystal layer when the electrodes are connected to a source of electrical potential; and

(f) ~~a~~ compensator in accordance with a specified one of claims 100, 110, etc., disposed between the polarizer layer and the analyzer layer.

29 ~~24~~. The liquid crystal display of claim 28 ~~23~~, wherein said compensator is optically matched with said liquid crystal layer to provide a desired viewing characteristic over a specified field of view.

add c67

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